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PROBLEM

PROBLEM SETTING



Signals from Global Navigation Satellite System (GNSS) satellites are altered in phase and amplitude by ionospheric scintillations. These scintillations can cause a loss of spatial tracking and time information.

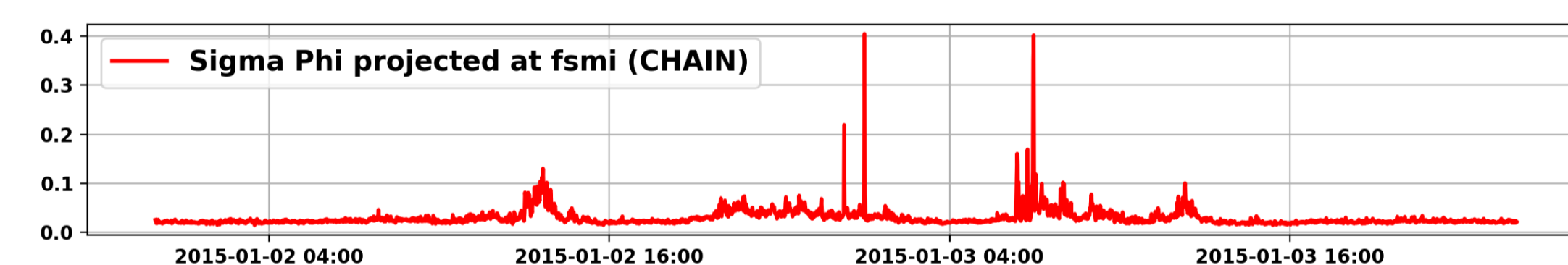
Scintillations are known to correlate with visible aurora. To investigate this correlation, we use data from several observation networks in N. Canada

QUESTIONS

- Are specific structures within the visible aurora more likely to correlate with the occurrence of GNSS phase scintillations?
- Can an unsupervised approach to aurora image classification improve our understanding of this correlation?

DATA SOURCES

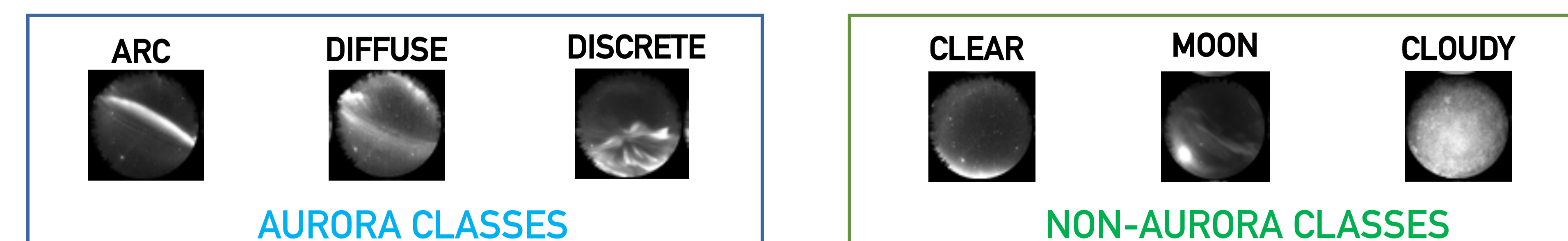
TIME SERIES



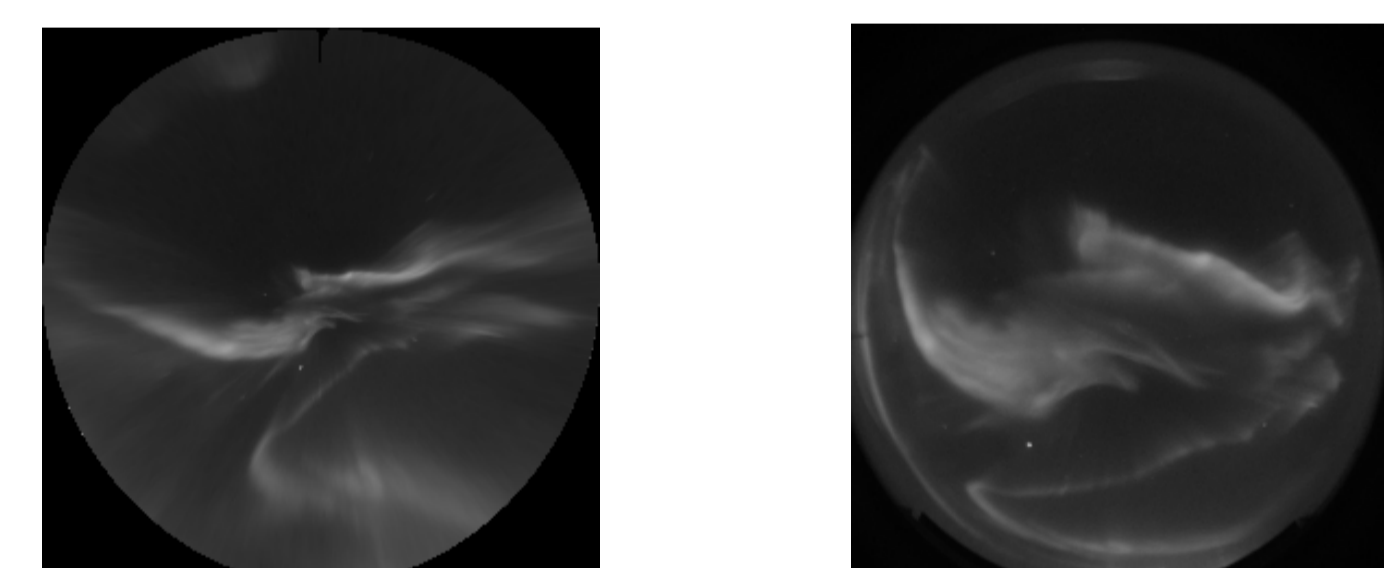
We use measurements of the ionospheric phase scintillation index (σ_ϕ), the standard deviation of the detrended carrier phase, averaged over 60 s.

THEMIS IMAGE CLASSES

7700 manually annotated auroral images, classified among 6 classes



AURORAL IMAGERY



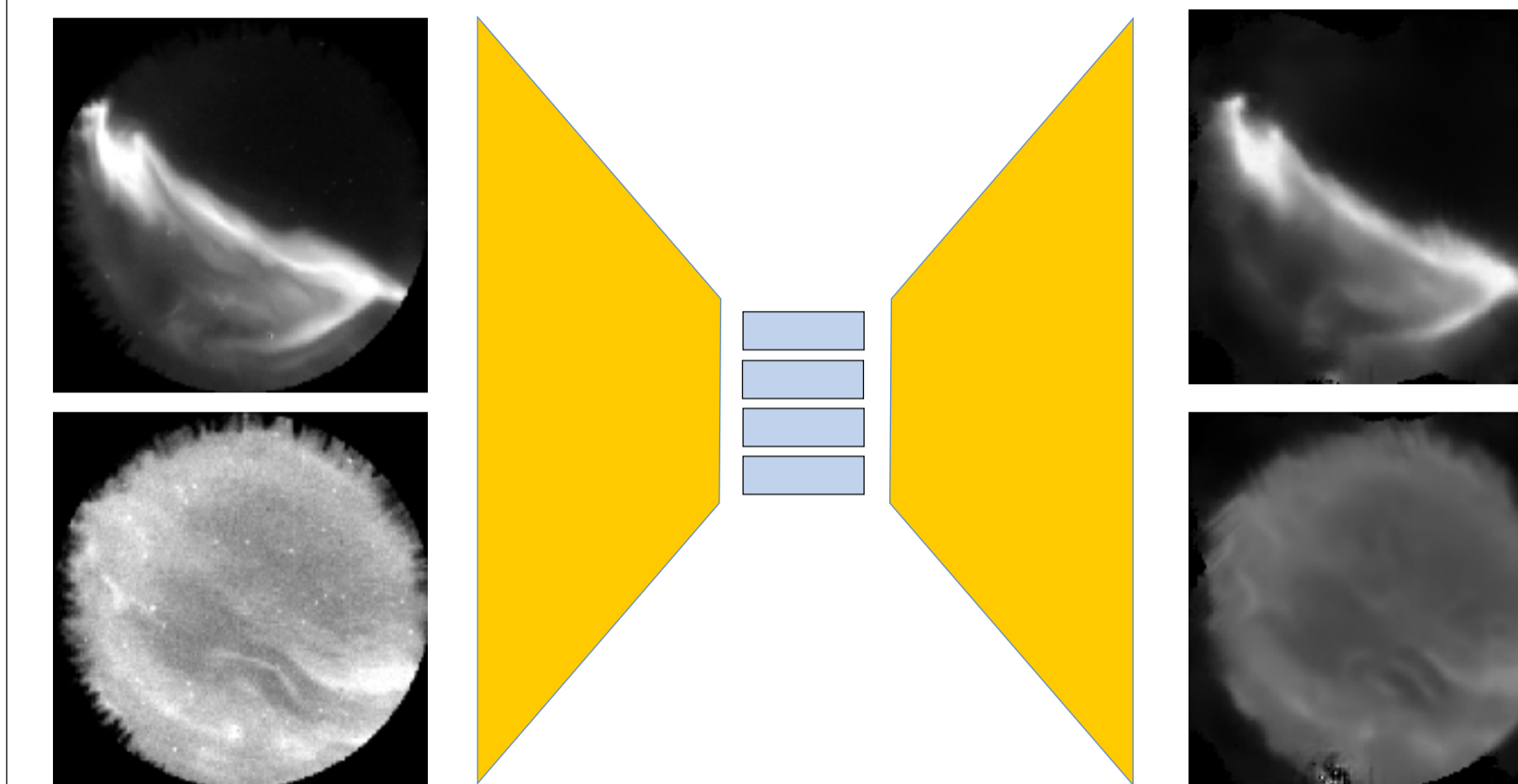
35,277 raw images from THEMIS all-sky imagers are projected onto a latitude-longitude grid. This data set was used to train the auto-encoder

ACKNOWLEDGEMENTS

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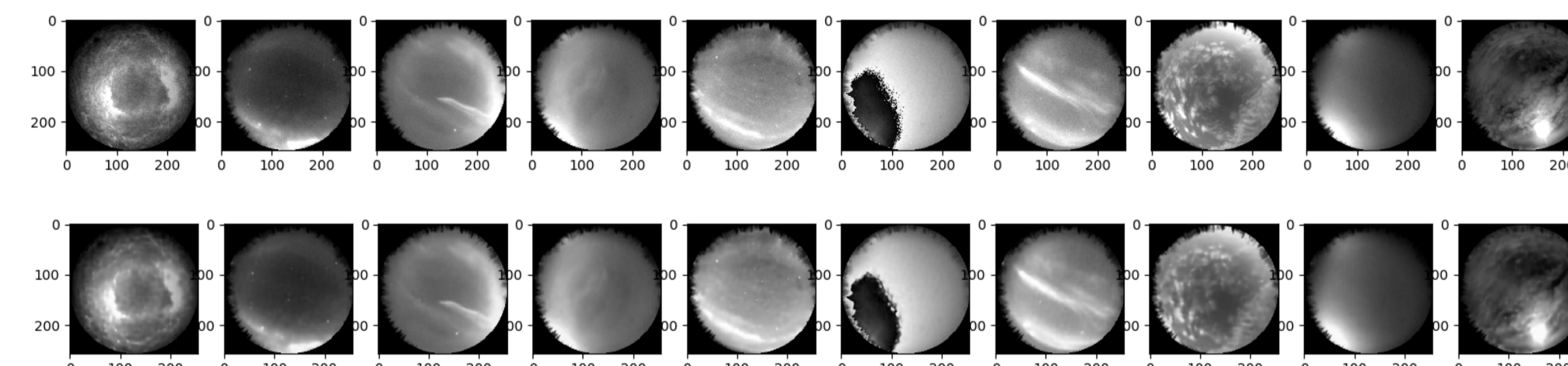
SOLUTION

AUTOENCODER



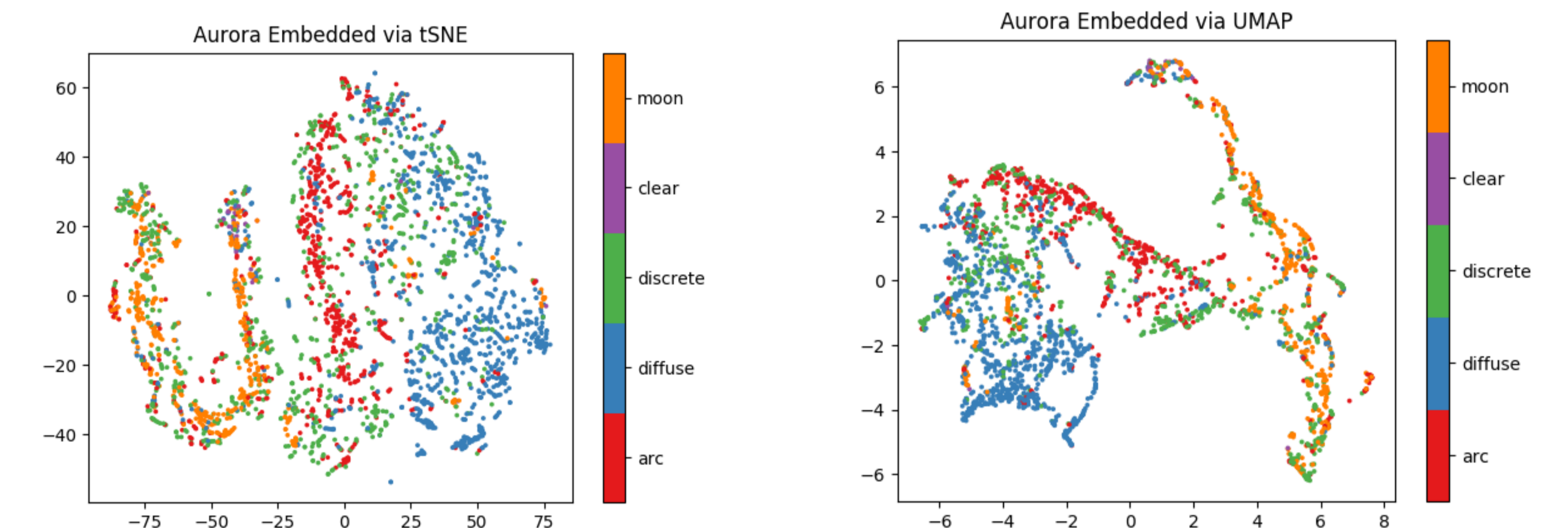
The encoder and decoder uses a U-Net like architecture in order to learn image structures at different scales.

Res-AE architecture for encoder.

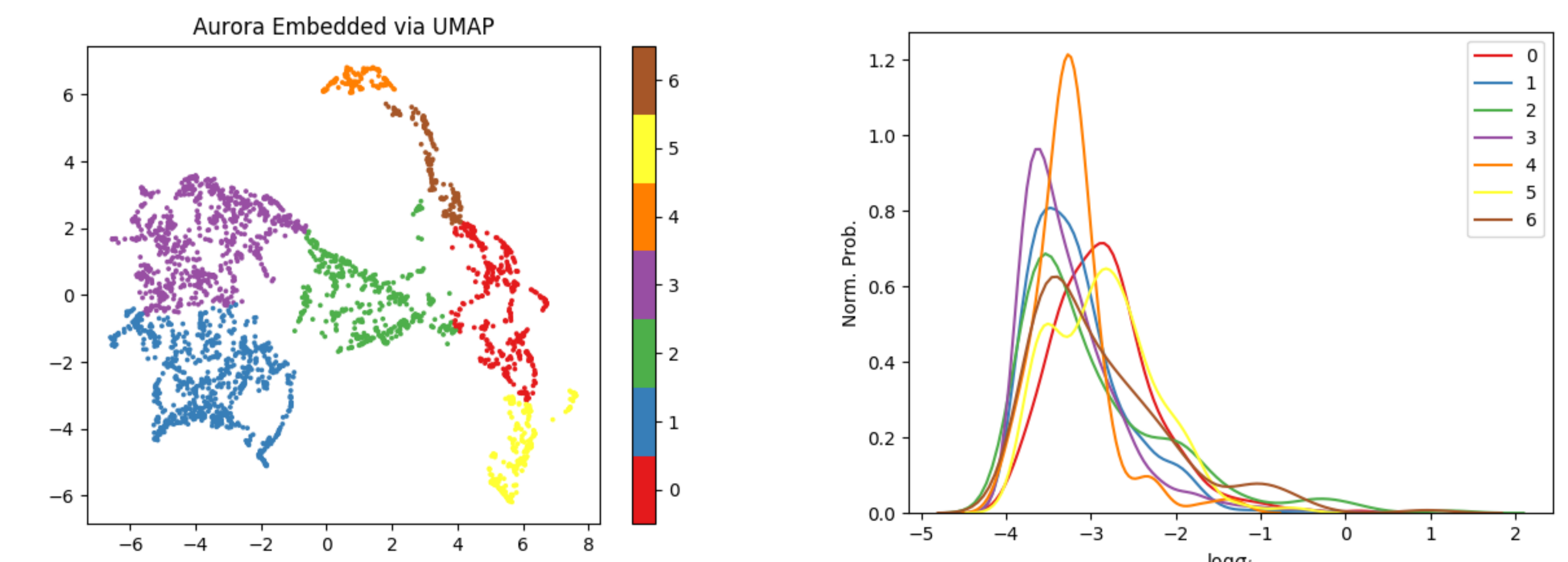


Original (top) and reconstructed (bottom) images

RESULTS



Visualization of aurora images in the latent space using tSNE (left) and UMAP (right). Unsupervised clusters typically correlate with human-annotated image classes and show similar clusters using both tSNE and UMAP.



Some clusters in the latent space (left) are more likely to be associated with higher phase scintillations (right). Clusters containing discrete and arc aurora classes are associated with higher phase scintillations.